

## **Adaptation to Climate Change**

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Historically, adaptation to climatic dangers and precautions in the face of climatic risks are normal modes of behaviour, which we all practice in one way or another; this practice is motivated by our perception of what is “normal” – a perception that often fails, however, to conform to the extent of the actual risks. On the assumption that nature – if not in its totality, then at least within limits – is practically controllable, deviations from this normal state of affairs are interpreted as proof that nature is changing, and as the effect of culpable behaviour (mainly) on the part of others. This behaviour must be overcome, and we too are ready to make our own small contributions. The alternative reaction, which is to infer that the present risk has been underestimated, and so to invest more in the strategy of precaution, is much more seldom chosen.

These attitudes and modes of behaviour can also currently be observed in the realm of public policy, with respect to reactions to anthropogenic climate change. In the foreground, we see both excessive public punishments for the “sceptics” of explanations for the current climate changes, and repeated assurances, not unlike a prayer wheel, that all this will nonetheless be turned to the good: the catastrophe can be averted, so long as we all just work hard enough at it. Only peripherally, if at all, is it mentioned that the climate change of human origin in the coming decades can only be reduced, but not avoided. What exact form the required adaptive and precautionary measures might take is discussed publicly as seldom as the question of the national and international distribution of the burdens, or the question of social decision-making mechanisms for managing the climatic consequences.

As long as the question of precautions is not seriously discussed in the public arena, despite research efforts that go largely ignored; as long as the present natural climatic dangers are dismissed as being under control, and the potential future growing risks are instrumentalised above all as a warning regarding the disastrous consequences of prevailing social practice; and as long as the question of climate is largely degraded to a means to an end, as an urgent call to reduce the emission of greenhouse gases, or

**understood as motivation to lead an ethical, more environmentally friendly life, it is apparent that no practical answers to the immediate dangers of climate change will be found.**

## **1. Climatic Dangers and Adaptation**

Climate, as an essential basic condition of their lives, has probably always fascinated human beings; the reliability of this basic condition has been the object of fear as much as of confidence. The “failure” of the climate in England in about 1315, for instance, was interpreted as divine retribution for sinful human behaviour. Today, we can still reconstruct phases of the climatic history of the Iberian peninsula by studying church records, which document processions meant to improve the climate (here: to soothe the wrath of God) and other theological activities.

Climatic anomalies, that is, continuous and frequent extraordinary weather situations, with negative consequences for humans and society in particular, have occurred again and again in historical times. Traditionally, these were understood as indications that human beings had done something to call down the wrath of God or of nature, since the scientific explanation that the climate is naturally variable regardless of human activity is difficult to square with our anthropocentric way of thinking. Thus, in the 19<sup>th</sup> century (and not only then) climatic anomalies were interpreted as nature’s reaction to massive deforestation. To this extent, society’s reaction that the causes of climate change must be combated is a course of action that has been culturally and historically anchored in our structures of thought and perception for at least 150 years.

In addition, there are also the ever-present and usually less spectacular precautions, expressed in building regulations and principles such as “Wer nicht diecken will, mutt wieken” (“whoever doesn’t want to help build dykes must leave”). Precaution recognises that there are residual risks, and that the climate, meaning the weather statistics, is not as reliable as our records suggest. The case of the unprecedented Baltic Sea storm surge of 12/13 November 1872, whose intensity far exceeded any storm surge previously observed on the German Baltic Sea coast, drastically demonstrates this unreliability of the climate and of estimating unavoidable residual risks. “Adaptation” to such extreme climatic dangers means that every individual must take precautions for him- or herself, for his community, for his social environment; must build and maintain dykes; must forgo draining water meadows for building land; must observe the building regulations or accept their tightening.

Why make these preliminary remarks about climatic dangers and human precautions? They are meant to demonstrate that the options of “adaptation to climatic dangers” and “mitigation of climatic dangers” are by no means new. An episode from Switzerland in the middle of the 19<sup>th</sup> century may serve as a further example. In the 19<sup>th</sup> century Switzerland experienced a series of terrible floods, which were perceived to be a new type of weather extreme. Science, at that time forestry, associated these changes with the practice of felling trees in the high mountains. The reaction to the frequency of floods then led to both a policy of mitigation (in today’s terms: climate protection) and a policy of adaptation. The Swiss *Waldpolizeigesetz* (Forestry Police Law) forced the regulation of human activity to avert climatic dangers (a ban on logging in the high mountains). The adaptation consisted of numerous hydraulic engineering measures to better cope with the masses of water. The *Waldpolizeigesetz* had useful effects, no doubt, but no significant effect on precipitation in Switzerland and therefore on flooding. The social problem of flooding was solved by means of hydraulic engineering: by adaptation.

Generally, today we observe that climatic risks are no longer seen as such. The responsibility for protection from these dangers no longer lies with the individual, or with the community. Climatic risks are being socialised. The state is supposed to see to it that security from such risks is guaranteed. When surprises occur, however, as in the case of the Elbe flood of 2002, which actually can only be considered surprising in the light of a kind of collective amnesia, then either the state has failed or the risk has changed (in a manner unforeseeable in advance by the individual). The fact that the individual has taken no precautions is considered to be of no importance. And after the flood a new house is built in the same place again, even more beautiful than the first, but in principle just as much endangered.

## **2. Perspectives on Altered Climatic Dangers**

Today, of course, the situation is different from that of the 19<sup>th</sup> century, when the Swiss foresters asserted that an unreasonable hunger for profit lay behind the hitherto supposedly unprecedented flooding.

We have observed for decades that the atmospheric concentration of carbon dioxide (and other greenhouse gases) is mounting; we know why this is happening, namely due to the continually increasing burning of fossil fuels such as coals, petroleum and natural gas. We observe that, largely in parallel to this accumulation of infrared active gases in the

atmosphere, the temperatures of the ground-level air layers and of the ocean's surface are rising.

A few years ago, it still required complex statistical detection methods to demonstrate, within a given probability of error (thus, within the framework of a statistical test of a hypothesis), that the most recent increases in global annual mean temperature could be seen as no more than rare, but nonetheless naturally-occurring, fluctuations in the climatic system. Today, a simple argument is sufficient: of the past 126 years for which we have reliable annual mean temperatures, the 12 warmest years fall in the period after 1990. How probable is it that we would find such a phenomenon in a stationary long-term correlated statistical series? The probability is one in a thousand – conservatively interpreted. With a probability that verges on certainty, therefore, we can proceed from the assumption that the climate is presently changing as a result of non-natural developments. The best explanation by far that we have for these changes is the increased concentration of greenhouse gases in the atmosphere due to human release of these substances.

The climate, then, is changing – this time really on account of *human* activity. This does not mean, however, that *all* the climatic changes that we can observe at present can be traced back to human activity. The rise in temperatures and the water level; the depletion of sea ice; the poleward migration of plants and animals; all this is almost certainly part of anthropogenic climate change. In terms of the frequency and intensity of storms in our regions of the world, we observe no systematic changes in the last 100 years, despite repeated assertions to the contrary by interested parties. The few data that reach back to Napoleonic times show a remarkable regularity, accompanied by decade-long ups and downs. With respect to precipitation events, too, claims are continually being made that we are presently seeing a threatening development. In view of the actual complexity of the data, however, there is no consensus among climatologists regarding such claims, but rather broad disagreement; just the same is true of disputed assertions about the current changes in Greenland's ice shield and the Antarctic, or about Atlantic hurricanes.

The most important sources for specifying potential future climate scenarios, the climate models, refer to how climatic risks can change; some climatic risks will shift spatially (for example, the storms in our latitudes will shift somewhat to the north), others will also weaken (for instance, cold spells), or yet others will intensify (such as heat waves, for example, or storm surges in some regions); moreover, there is some evidence that heavy precipitation in our latitudes will increase in intensity. How extensive these changes will be is still under

discussion, but there is agreement among climate researchers that these changes will become manifest in the course of the century – though hardly in the next decade or two.

These expectations of possible changes are based on assumptions about future emissions – and thus ultimately on assumptions about, for example, how many Chinese in the coming decades will drive to the supermarket to buy vegetables or meat; and in what kind of vehicles, how often and how far they will do so, how far the vegetables or meat will have travelled before being sold in the supermarket. The fewer fossil fuels are used, the fewer methane-emitting animals are kept – the smaller the resulting change in the climate. There is the possibility, then, of limiting the degree of climate change. But whether this possibility can be practically realised is another story. Since Rio in 1992, when major concerns regarding a changing climate were acknowledged for the first time, not much has happened to give encouragement in this respect, if we disregard heroic declarations, symbolic acts and acclaimed rock concerts.

There is still time, then, to take precautions in the face of changing climatic conditions – except in those cases where present investments have set conditions for many decades in advance. The limitation of climatic changes – and limitation alone concerns us here, not avoidance – indeed requires urgent action, since it is the accumulated release of carbon dioxide and other greenhouse gases into the atmosphere that is responsible for these changes in the course of the century; and coal-burning power plants, once built, are amortised over many decades.

### **3. Options for Reaction**

In terms of climate policy, then, we are once again faced with the well-worn old choice between “mitigation” and “adaptation.”

In Germany, in Scandinavia, but also in Great Britain and many states in the USA, in the public debate we hear almost exclusively about the first option, climate protection: “protecting the climate from humankind,” reduction of emissions. Energy policy becomes climate policy, and climate policy turns to energy policy. Energy policy further becomes industrial policy, environmental policy and ultimately social policy. There are hopes of developing effective and attractive technologies, so that Germany, land of high technology, not only gains for itself an exemplary environmental management, including climate management, but also takes the lead in mastering the challenges of globalisation.

The other option for mitigation, namely, the neutralisation of increased production of carbon dioxide in the process of energy extraction, by means of deposition, precipitation, vacuum extraction from the air or artificial reflection in the stratosphere, is discussed almost only in academic and technical circles and currently does not stand a chance in the public discussion.

The necessity of adaptation to changed climates, of precautions in the face of changed risks, is hardly discussed in public; but it is certainly being concretely considered, planned and partially implemented in government agencies and private enterprises. To be sure, a mayor will reap more approval from his voters if he positions himself at the forefront of rescuing the climate than if he is already publicly considering what the dimensions of the city sewer system might have to be if the climatologists' scenarios are accurate. At present it is unlikely that one can win elections by "protecting humankind from the climate," but it might be done by "protecting the climate from humankind."

#### **4. The Shadow of Climatic Determinism**

Why is it a serious matter for our society that the climate is changing, and will go on changing, as a result of human activity? In an extreme case, the world could become uninhabitable, but presently there is no evidence to suggest this. If the water level increases by 7 metres in the coming century, this would most probably mean the end for many coastal regions; if the sea level takes 800 years for this rise, however, we will take a more relaxed view of a change of this extent. In many parts of the world, living conditions will be different in the coming decades in any case, simply due to the consequences of economic globalisation, expected economic growth, social change and new technologies. The world of 2050 will be at least as different from that of the year 2007 as the latter from that of 1964, or that of 1964 from the world in 1931.

Without a doubt it is necessary to limit the oncoming changes, but we must also clearly understand that these interventions must be "paid for" – by forgoing other chances and opportunities. This is a decision that each society must make for itself, in a manner consistent with its values. If societies arrive at a particular outcome on the basis of their preferences, then so be it. No one should assert, however, that the available facts have forced upon them the consequences thus chosen.

We are convinced that demands for the unconditional avoidance of climate changes also represent a link to the scientifically discredited ideas of climatic determinism. Climatic determinism is that ancient school of thought which holds that climate greatly influences – if not guides and determines – human beings, societies, the success of entire civilisations. This idea can still be found in the first half of the 20<sup>th</sup> century in all good middle-class encyclopaedias, under the heading “Climate.” According to these ideas, inhabitants of the world’s maritime-influenced middle latitudes are particularly successful because they are faced with a stimulating climate, while inhabitants of the tropics and humans in uniform climates simply lack the economic and intellectual potential for want of climatic challenge. Today, no one speaks any longer of climate as a determining factor. But behind worries about changes in the climate there lurks the idea that humans and their society will no longer be in “balance” with their climate. (Ecosystems are seen in just the same manner; in this context the question of whether there presently exist any “balances” is difficult to answer, given the influence of such factors as air and water pollution, the import of foreign species, overfishing and agriculture). If there indeed is such a thing as a natural balance (and a corollary influence upon human behaviour) between climate, humans and society, then we must conclude that any change in climate is a serious disruption for humans and society, which must be avoided.

We believe that prescientific ideas of just this kind are in play when the significance of climate change and climate protection is discussed today. The testing of this hypothesis, which seems plausible to us in view of the prevailing public argumentation, requires a more systematic implementation of the social and cultural sciences, in order to illuminate more closely the processes of social construction and work out in more detail their implications for the processes of building political will. Unfortunately, social and cultural sciences have hitherto hardly been ready to take up these topics – on one hand because the situation calls for a difficult transdisciplinary mixture, but likely also due to the extensive politicisation of post-normal climatology.

## **5. The Moralisation of the Options**

In discussing the reactions to climate change, normative positions play an important role. We have only borrowed the world from our children, they say; for our own well-being we must live in harmony with nature. We must be the “vanguard,” which means nothing more than that we ought to be the moral compass of the world.

From the viewpoint of this morality a further change to our natural world, insofar as it still exists, is to be avoided as much as possible. In doing so, our efforts need not be cost-effective for us, for our concern is with higher values, with the well-being of the world itself. Thereby we overlook that there are also other moral precepts; for example, those that speak of freeing human beings from the restrictions of a nature that confines, from hunger and poverty. That was the program of the last two centuries in Europe and the US, it is the program in China and India today, and will hopefully be the program of Africa in the coming decades. Often enough, children have no interest in their parents' legacy; we too, indeed, were not really that happy with what was left us.

In the eyes of the developing world, climate change and climate protection are projects of the postmodern West, a new attempt to intellectually colonise the rest of the world. An attempt that causes damages in the Third World when, for example, tourists no longer fly to the Seychelles, and so their money also stays away; or when air pollution in Shanghai is to be ameliorated by inefficient means, reducing the emissions of CO<sub>2</sub>, to be sure, but only indirectly combating the really harmful chemical pollution.

In this moral fog of an affluent society in which electricity comes from a wall outlet, the real challenges disappear into the background. One of these challenges is for industry, for technological development, to turn the corner with new, economically efficient products and technical processes. Fundamental reductions in emissions will not be achieved by using energy-saving light bulbs in German townhouses. It is not the mass utilisation of bicycles, but rather the implementation of efficient automobiles in China that will make a difference; a better technology for utilising coal would help. This is where Europe can, and should, make fundamental contributions. These contributions are urgently necessary to extensively reduce climate change of human origin, and thus to bring its consequences better under control.

At the level of the individual, every increase in the efficiency of energy use makes sense, but it does not "save" the climate, as is continually suggested. Individuals, communities and cities bear the responsibility to minimise their vulnerability to climatic dangers – and indeed in terms of present dangers as well. Reduced vulnerability today also means reduced vulnerability tomorrow, when climate change will be that much easier to perceive. For the EU this means creating basic conditions so that the process of modernisation, which is already underway in any case, leads to society being less susceptible to climatic risks; and to climatic extremes being better withstood. In this context, industry and technology are once again



challenged to come up with innovative and efficient solutions that will then lead to a higher quality of life not only here in Europe, but also in other parts of the world.

## **6. A Plea for a Restricted Optimism**

The situation is serious. The very things that define the quality of life in the western nations are changing the climate; the rest of the world has set out to reach a comparable quality of life, thus contributing to massive climate changes. It seems impossible to halt this process completely; efforts to limit the increase in the release of greenhouse gases have had little success up to now; society's desire for extensive, enduring reductions has led to few presentable results.

Nonetheless, we are not pessimistic; we anticipate that the modernisation of technology and of social organisation, which is already constantly ongoing for economic reasons, will lead to significant increases in energy efficiency; all the more when this modernisation is accompanied by appropriate basic political conditions, by political strategies that promote energy efficiency and carbon-neutral processes. Emission trading will be helpful, but so too will a long-term securely planned environmental policy, so that firms gain the chance to optimise their products and services in a manner consistent with long-term goals of this nature. If fuel costs are to remain at a high level for the foreseeable future, then it makes economic sense for a ship-owner, for example, to build an additional ship, so that 8 container ships may ply the world's oceans at 22 knots instead of the previous 7 ships at 25 knots. Thus the fuel consumption would be reduced by about 25%; though this would be partly offset, of course, by the costs of building and maintaining one more ship.

We also know, however, that the previous climatic risks will continue to exist, for instance, in the form of dangers posed by weather extremes; their occurrence will shift regionally; some will intensify, others dwindle. Climatology is in a position to offer prospects for these changes in the coming decades – not in the sense of exact predictions, but in the sense of trends and opportunities that facilitate a rational planning process. With the aid of these scientific findings, it will be possible to achieve a better degree of adaptation to current and potential future climatic dangers; the instruments to do so come from the realms of industry (materials, for instance, or new agricultural products) as well as the law (risk-adequate building regulations) and landscape management (such as the clearing of flood control storage areas), in addition to improved forecasts of extreme events (such as floods or storm surges). European research into climate and its consequences is not in a bad position to meet these

challenges. This requires, of course, the comprehensive integration of the humanities and the social sciences, as well as intensive interdisciplinary collaboration.

## **7. The Case of Storm Surges in Hamburg**

In conclusion we will refer to one further example: the storm surges in Hamburg. Since February of 1962, not only Hamburg but rather all of Northern Europe knows the danger posed by storm surges. For a hundred years it had been quiet along Hamburg's dykes; since 1850 they had not been seriously challenged. In 1962, however, the dykes gave way at many points; there were many victims. The risk had obviously gone unrecognised above all in the Wilhelmsburg section of the city, where the dead were particularly numerous; presumably, people had other worries, they were busy with reconstruction after the devastating war, their first car. Hamburg had not adapted to the risk.

The next part of the story is well known – the coastal protection was massively raised everywhere along the German North Sea coast, including the Elbe estuary, and thus the even higher flood of 1976 was withstood with only minor damages and without loss of life. Since then high storm surges have amassed, so that early warning voices at the beginning of the 1990s blamed the storm surges on anthropogenic climate change. For several years it has been significantly calmer, both in terms of storm surges and among those warning voices.

What had happened? Three things: first, the climate changed; after an intensification of storm activity from about 1960 until 1990, which more or less counterbalanced a long downward trend since the turn of the 20<sup>th</sup> century, the storm climate has become milder again. Evidence that these changes are connected to anthropogenic climate change is lacking. Second, the line of dykes along the lower Elbe was shortened in order to raise the coastal protection. Third, in the meantime the waterways were excavated to a depth of 14 m, to accommodate shipping traffic in the era of massive globalisation. These last two factors have had the effect that the tidal surge flows up the Elbe toward Hamburg more rapidly and with less hindrance – about an hour faster than in the past. Therefore, storm surges also run upstream more rapidly and easily, with the result that storm surges in Hamburg now reach about 1 m higher than they do at the mouth of the Elbe in Cuxhaven; before 1962 this difference was no more than about 30 cm. To this extent, storm surges in Hamburg nowadays run aground about 70 cm higher, due to anthropogenic changes; it is estimated that about  $\frac{3}{4}$  of this amount can be attributed to the improved coastal protection, and  $\frac{1}{4}$  to the deeper waterways.

The coastal protection along the Elbe is found effective in safety assessments; die waterway is deep enough to permit large container ships to reach Hamburg. Thus, the desired goal has been reached.

An unwanted side effect is the acceleration of the tidal dynamics, and – associated with this – increased sedimentation, leading to a significant increase in the need for dredging. In the last few years it has become clear that the tidal dynamics must be slowed by means of new hydraulic engineering measures, in order to make possible a sustainable waterway of sufficient depth. This is a major scientific and technical challenge.

The prospect of slowing the tidal dynamics, however, is at the same time an opportunity to confront the consequences of anthropogenic climate change. Current studies suggest that near the end of the 21<sup>st</sup> century, storm surges in the Elbe could once again rise about 60-70 cm higher than they do today – due to anthropogenic climate change. If it is possible partially or completely to reverse the tidal dynamics that were intensified by hydraulic engineering in the first place, then the height of storm surges will also be restricted, and the anticipated climatically-caused increase in risk might possibly be considerably lessened.

This is only one example of how modernisation, foresight, precautions and adaptation to altered climatic conditions can be constructively combined. There are certainly many cases and possibilities that deserve a more careful scientific investigation. Whether this point of view can ultimately be effectively implemented will be proven only in the future. In any case, however, it is well worth thinking about.

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